UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH ADMINISTRATION
BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

RMO

Project | Date Feb. 26, 1942 | Author

SUBJECT—

TITLE

THE OCCURRENCE OF TOPKILLED PINES IN THE 1940 INSECT LOSS

BLACK'S MOUNTAIN EXPERIMENTAL FOREST

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INDEX NO.—

U. S. GOVERNMENT PRINTING OFFICE 16—47272-1

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THE OCCURRENCE OF TOPKILLED PINES IN THE 1940 INSECT LOSS

BLACK'S MOUNTAIN EXPERIMENTAL FOREST

For several years the Bureau of Entomology and Plant Quarantine has given attention to the phenomenon of topkilling in ponderosa pines. In order to obtain a general understanding of the factors responsible for such injury and to determine the significance of the injuries in the subsequent health of the trees, a comprehensive plan of investigation was drawn up and begun at the Black's Mountain Experimental Forest in 1936. Field work for the study has been continued and is still in progress. One phase of the general study has been the collection of mortality records of topkilled trees. For this purpose the Bureau has made a practice of noting the presence of previous topkilling for each infested tree recorded in the annual loss cruises on the experimental forest. In this report is presented an analysis of the mortality record of topkilled trees in the 1940 record of loss. Because of the limited amount of data that are available, the analysis must be regarded as merely preliminary and suggestive. Its chief value may be in directing attention to certain problems for which more data should be obtained.

Objectives

The primary purpose of the report is a consideration of the incidence of topkilled trees in the 1940 insect loss. This information, however, to be of value in estimating the significance of topkilled tree occurrence in the infestation, requires comparison with the topkill occurrence in the green stand. For purposes of the analysis, therefore, records of topkill occurrence in a sample of the green stand are drawn upon also. The presentation of the data, and the discussion will be directed towards these two objectives:

1. To determine and compare the incidence of previously topkilled trees in the insect loss and in the sample green stand.

2. To determine the mortality rates of the topkilled trees as a group, and in relation to tree age.

Definitions

Topkilling: In the field the practice has been to classify as "topkilled" all trees that have suffered an injury to the upper bole sufficient to kill the bole and crown above the point of injury. In the insect loss, trees with topkills are so rated if the injury has taken place previous to the year of insect attack. By this means such trees are differentiated from those in which an insect infestation of the current season may have begun in the top and progressed downward.

Age of topkilling: Age of the topkilling injury prior to the year of death is given no consideration. The data, therefore, include "red tops" of the previous season, as well as the older "black tops" and "stag" or "spike tops."

Amount of topkilling: The amount of topkilling ranges from small injuries involving perhaps only the leader of the stem to those of major size affecting more than 50 percent of the length of the bole.

Presentation and Discussion of the Data

The incidence of previously topkilled trees in the insect loss and in the green stand

The mortality figures of the topkilled trees in the 1940 insect loss are shown in Table 1. Of the 621 infested trees on the forest, 206, or 33 percent, had been previously topkilled. The volume of the topkilled loss was 304,439 board feet, or 38 percent of the total volume. These figures indicate that trees previously topkilled were an important element in the 1940 infestation.

Table 1. The Occurrence of Topkilled Trees in the 1940 Insect Loss on B. M. N. F. Virgin Area

Block	Total Loss		Topkilled Loss		TK - % Total Loss	
	Trees	Vol. B.M.	Trees	Vol. B.M.	Trees	Vol. B.M.
A	38	60,428	14	22,344	36.8	37.0
B	130	169,456	44	66,137	33.8	39.0
C	191	234,077	63	87,555	33.0	37.0
G	89	136,245	35	54,344	39.3	39.9
F	173	202,240	50	74,059	28.9	36.6
All	621	802,446	206	304,439	33.2	37.9

Average volume per tree: Board Feet

topkilled loss -	1,478
total insect loss -	1,292
insect loss without topkills -	1,200

Comparison of topkill loss distribution by forest blocks shows no variation of very great magnitude. The consistency in volume percentages is particularly good, with a maximum departure of only 5 percent from the average. As indicated by the difference between the tree percentage (33%) and the volume percentage (38%) of topkilled trees in the loss, the volumes of such trees averaged higher than those of the insect loss as a whole. The average volume per topkilled tree was 1,478 board feet. The average volume of all trees in the insect loss was 1,292 feet, and of trees without topkills, 1,200 feet.

To evaluate the significance of the occurrence of topkilled trees in the infestation, comparison should be made with their occurrence in the green stand. Data on the green stand occurrence of topkilled trees do not exist for the experimental forest as a whole, but records are available of their frequency in the green stands of several plots. These may be used as a 5 percent sample of the forest for purposes of comparison with the loss figures.

Of the 5,162 trees on the sampled area 347, or 6.7 percent, were topkilled. In volume 494,015 board feet, or 9 percent of the total, was in the topkilled category. Comparison of these percentages with the mortality percentages (Table 1) shows that the topkilled trees have a greater frequency in the insect loss than in the green stand. This relation between loss occurrence and stand occurrence of topkilled trees agrees well with other data of a somewhat similar character obtaining for the forest as a whole. In 1937 the Forest Experiment Station found that trees previously classified as "salvage trees" had a high occurrence in the insect loss. These "salvage trees" included a high proportion of the previously topkilled trees of the stand. Their occurrence by volume in the green stand amounted to 7.74 percent. Their occurrence in the insect loss, however, amounted to 33.36 percent. The magnitude as well as the difference of these percentages corresponds closely to the topkill loss percentages of the present study.

Mortality ratios of the topkilled trees

From the green stand and mortality percentages it is possible to compute the mortality ratios of topkilled trees. Using the tree percentages, it is found that the ratio of mortality is 4.96. This indicates that the death rate of such trees is almost five times as great as would be expected if insect attacks were made at random in the stand.

A comparison may be made of the mortality ratios of trees with, and of trees without topkilling. While trees without top injury make up 93.3 percent of the green stand, they occur in but 66.8 percent of the total loss, giving them a mortality ratio of .72. Dividing this ratio into 4.96 indicates that the mortality rate of topkilled trees is seven times that of trees without topkills, illustrating the considerable differential in the mortalities of these two types of trees.

The rates of mortality of topkilled trees in relation to age

Calculation of the average volumes of infested topkilled trees showed that they were of larger size on the average than were the infested trees without topkills. Thus the average volume per tree of the former was 1,478 board feet, as compared to the average of 1,200 feet for the latter. These data, because of the general relation between size and age, suggest that there was a relatively greater number of trees of older age in the topkilled loss than in the loss without topkills. To obtain some evidence of whether or not this was the case, the trees of each category were distributed by percentages in the seven Dunning classes (1), as in Table 2.

From the table it will be seen that the overmature trees of Class 5 make up 25 percent more of the loss in the topkilled group than in the group without topkills. In the former case the 5's account for 75 percent of all the tree loss, in the latter but 50 percent. The old overmature trees predominate to a markedly greater extent in the topkilled loss. For the other classes (except 2's) the reverse relationship holds true. These have a relatively greater occurrence in the mortality record of trees without topkills.

Table 2. Distribution of 1940 Insect Loss, with and without Topkills, in Dunning Tree Classes (Tree data only)

Dunning Class	Topkilled Trees		Trees without Topkills	
	Number	Percent Total	Number	Percent Total
1	3	1.5	13	3.1
2	5	2.4	10	2.4
3	16	7.8	81	19.8
4	22	10.7	67	16.0
5	155	75.2	206	49.8
6			4	1.0
7	5	2.4	34	8.1
Total	206	100.0	415	100.0

The data just given indicate the relative extent to which trees of different age classes participate in the mortality record. It provides no idea, however, of the real mortality rates of topkilled trees of different ages. Expression of the mortality data in the form of mortality ratios will have much more significance in appraising the susceptibility of topkilled trees of different ages to insect attack and death. The mortality ratios of the topkilled trees when distributed into the seven Dunning tree classes are shown in Table 3.

Table 3. Mortality Ratios of Topkilled Trees by Dunning Tree Classes (Tree data only).

Data	Dunning Tree Classes							Total
	1	2	3	4	5	6	7	
Topkills-% Sample Green St.	.93	.27	.70	.45	4.07	.0	.29	6.72
Topkills-% 1940 Loss	.46	.81	2.56	3.54	24.96		.81	33.17
Topkill Mortality Ratio	.52	2.97	3.70	7.94	6.14		2.77	4.94

Of the six classes for which there were data, topkilled Dunning 1's only had a mortality ratio below what would be expected on the basis of stand occurrence. In all other classes the trees have a death rate markedly above the expectancy. Dunning 3's, 4's, and 5's show the highest mortality rates, the 3's having a death rate almost four times above the normal for stand occurrence, the 4's almost eight times, and the 5's six times. It would appear, therefore, (1) that topkilled trees of every age and position, other than the young, vigorous dominants, may be decidedly susceptible to insect attack and death, and (2) that the mature and overmature trees are particularly susceptible. These data have much significance for studies of factors influencing the susceptibility of trees.

Summary

The frequency of occurrence of topkilled trees in the 1940 insect loss is presented and compared with the occurrence of the topkilled trees in a sample of the green stand. With these data certain relationships bearing on the susceptibility of trees to infestation following topkilling are analyzed in a preliminary way. The data, while suggestive of significant relationships, are too few to permit definite conclusions. The following points may be mentioned, however:

1. Topkilled trees were an important element in the 1940 loss, accounting for 33 percent of the total infested trees and 38 percent of the total volume.

2. Topkilled trees show a death rate almost five times the expectancy based upon their occurrence in the green stand. This mortality rate is seven times that of trees without topkills.

3. All topkilled trees except the young dominants appear to be markedly susceptible to insect attack.

4. Topkilled trees of mature and overmature age appear to be particularly susceptible to insect attack.

5. In amount the Dunning 5 trees contribute more than any other class to the total topkilled loss. They make up 75 percent of the total.

Literature Cited

1. Dunning, D. 1928. A tree classification for the selection forests of the Sierra Nevada. Jour. Agr. Res. 36(9):755-771. 6 Figs., 6 Pl.

Respectfully submitted,

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Berkeley, California
February 26, 1942